

Final Report/Summary of Research
Planetary Atmosphere Dynamics
and Radiative Transfer

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CASE

Introduction

This research program has dealt with two projects in the field of planetary atmosphere dynamics and radiative energy transfer, one theoretical and one experimental. The first project, in radiative energy transfer, incorporated the capability to isolate and quantify the contribution of individual atmospheric components to the Venus radiative balance and thermal structure to greatly improve the current understanding of the radiative processes occurring within the Venus atmosphere. This is possible by varying the mixing ratios of each gas species, and the location, number density and aerosol size distributions of the clouds. This project was a continuation of the work initiated under a 1992 University Consortium Agreement. Under the just completed grant, work has continued on the use of a convolution-based algorithm that provided the capability to calculate the k coefficients of a gas mixture at different temperatures, pressures and spectral intervals from the separate k -distributions of the individual gas species.

The second primary goal of this research dealt with the Doppler wind retrieval for the successful Galileo Jupiter probe mission in December, 1995. In anticipation of the arrival of Galileo at Jupiter, software development continued to read the radioscience and probe/orbiter trajectory data provided by the Galileo project and required for Jupiter zonal wind measurements. Sample experiment radioscience data records and probe/orbiter trajectory data files provided by the Galileo Radioscience and Navigation teams at the Jet Propulsion Laboratory, respectively, were used for the first phase of the software development. The software to read the necessary data records was completed in 1995. The procedure by which the wind retrieval takes place begins with initial consistency checks of the raw data, preliminary data reductions, wind recoveries, iterative reconstruction of the probe descent profile, and refined wind recoveries. At each stage of the wind recovery consistency is checked and maintained between the orbiter navigational data, the radioscience data, and the probe descent profile derived by the Atmospheric Instrument Team. Preliminary results show that the zonal winds at Jupiter increase with depth to approximately 150 m/s.

Planetary Atmosphere Dynamics and Radiative Transfer

1 Project Accomplishments - 1995

During the calendar year 1995 the work completed under this grant has been primarily in the area of planetary radiosciences. For a description of the Venus radiative transfer work completed to date under this grant, please see the Performance Report/Summary of Research for 1994 (attached).

1.1 Galileo Doppler Wind Experiment

During 1995 the software for reading the Galileo experiment data records was tested and integrated into a software package for conducting the Doppler wind retrievals. The development of the data analysis and wind retrieval software was initiated and completed. Software testing and sample wind recoveries using properly formatted data sets from JPL were demonstrated. The key accomplishments in 1995 are:

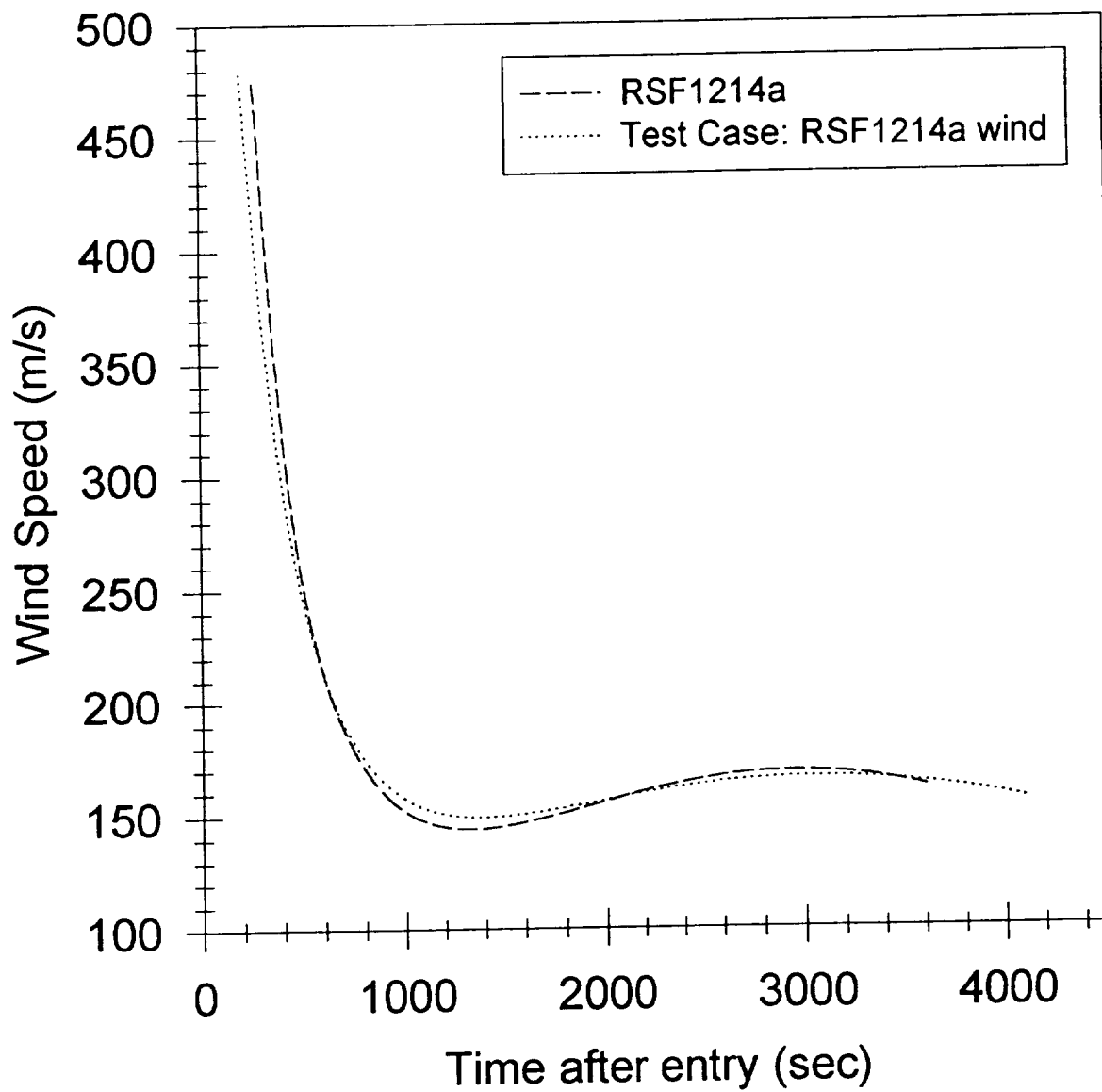
1. Complete software to read radioscience data from tape, probe and orbiter trajectory data from disk.
2. Complete software to read radioscience CDS data.
3. Complete and test Doppler wind recovery software.

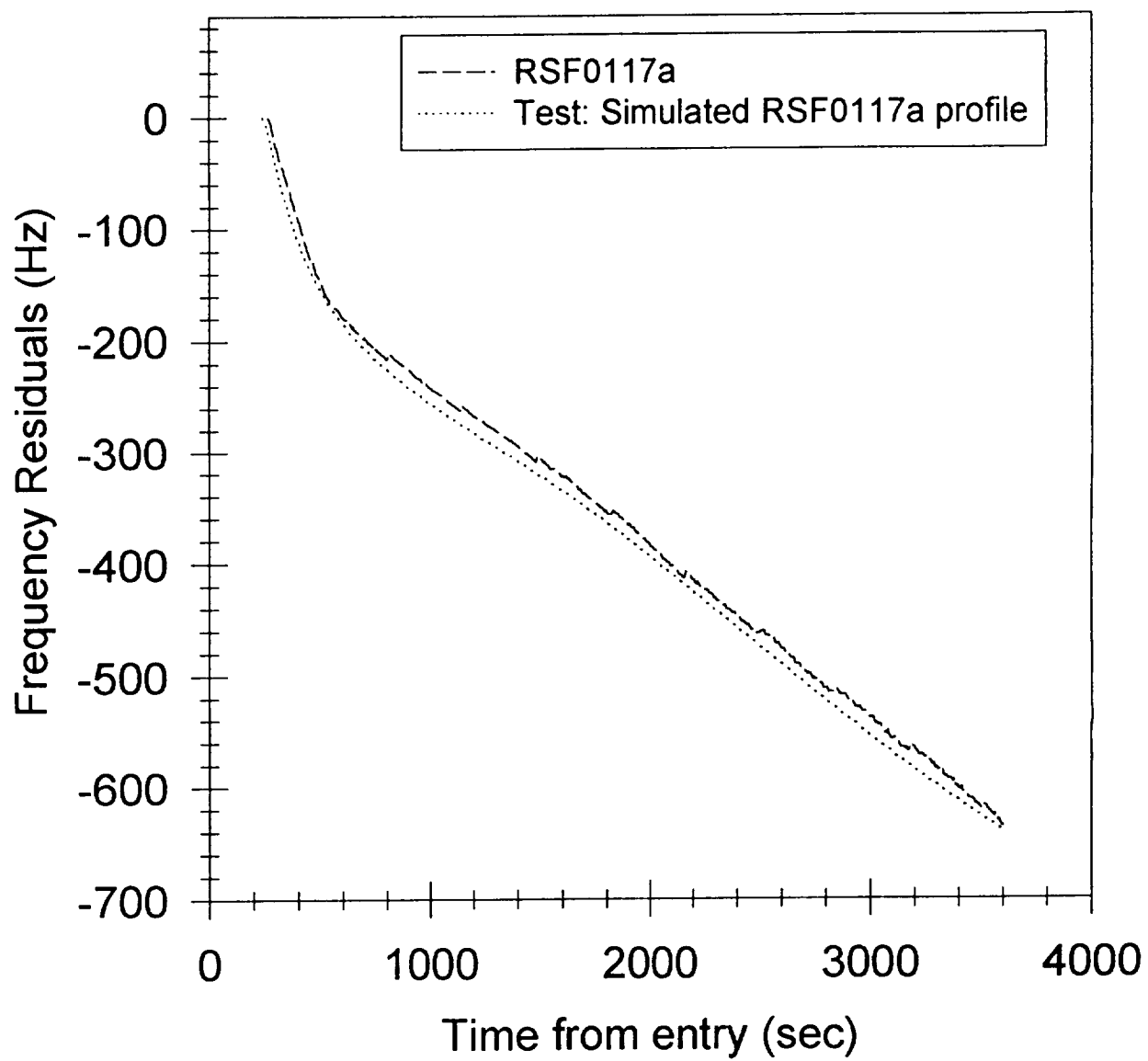
We have completed the development of software to read the "Quick Look" (1/2 resolution) data that was received several days following the probe mission. The quick look data, provided in unformatted ascii, contains the probe radioscience (frequency) data vs. time. This data set has provide an opportunity to conduct a preliminary check of the radioscience data, and perform preliminary wind recoveries. The wind recoveries are performed by analyzing the radioscience data with the probe and orbiter reconstructed trajectories from the Navigation and the Atmospheric Structure Instrument teams.

On December 7 the Galileo probe arrived at Jupiter. Preliminary radioscience data was delivered on December 9, with several more readouts in the following days. Preliminary analyses of the Doppler residuals (see Figure 1) show a wind profile that remains high to the end of the probe mission. Since the retrieved wind speeds vary strongly depending upon the accuracy of the probe and orbiter trajectory models, an accurate wind

measurement will therefore depend on the development of refined probe and orbiter positions and velocities during the period of the relay link. The current best estimate is that the winds stay strong, possibly greater than 150 m/s to depth. An anomalous wind velocity is found in the first 500 seconds of the descent. In all likelihood this wind "spike" is due to errors in modelling of the probe descent velocity early in descent (see Figure 1). These preliminary results were presented at the Project Science Group Meeting (PSG) at NASA Ames Research Center on December 19, 1995. The attached figures show the Doppler frequency residuals, and the retrieved wind profile.

2 Figures





3 Performance Report, 1994